㊾発明の名称 文字認識装置

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明 細 書

1．発明の名称
文字認識装置
2．特許請求の範囲
1．複数の字種の文字パターンを記憶する辞書部（1）と、

認識対象の文字列を構成する各文字の形状に関するデータを入力して特徴を抽出し、前記複数の字種の文字パターンと比較して、該各文字に対して類似度の高い文字パターンの文字を認識文字候補として選出する認識文字候補選出手段（2）と、

前記文字列における該各文字について、
該各文字の前後の文字に対して最も類似度の高い認識文字候補の字種が互いに同一の第1の字種であり、且つ、該各文字に対して最も類似度の高い認識文字候補の字種が、前記前後の文字に対して最も類似度の高い認識文字候補の字種と異なる第2の字種である場合に、該各文字に対する前記最も類似度の高い認識文字候補の類似度と、該各文字に対する前記認識文字候補のうち前記第1の字

種のものの中で類似度が最も高いものの類似度との差を置換可能度として求め、前記前後の文字に対する前記最も類似度の高い認識文字候補の類似度と、該前後の文字に対する前記認識文字候補のうち前記第2の字種であるものの中で類似度が最も高いものの類似度との差を置換可能度として求める置換可能度演算手段（3）と、

前記各文字および該各文字の前後の文字の置換可能度を、それぞれに対応して予め定められたしきい値と比較し、該それぞれに対応するしきい値を基準として、該各文字の置換可能度が小さく、且つ、該前後の文字の置換可能度が大きいという置換可能条件を満たすとき、該各文字は、該各文字に対する前記認識文字候補のうち前記第1の字種であるものの中で類似度が最も高い認識文字候補に等しいと認識し、該置換可能条件を満たさないとき、該各文字は前記最も類似度の高い認識文字候補に等しいと認識する認識文字処理手段（4）とを有してなることを特徴とする文字認識装置。

2．前後の文字に対して最も類似度の高い認識

文字候補の字種が同一の字種であり、且つ、自文字に対して最も類似度の高い認識文字候補の字種が、該前後の文字に対して最も類似度の高い認識文字候補の字種と異なる字種であり、さらに、該自文字の前記置換可能度が前記しきい値以下である文字が2文字以上連続して存在するとき、該連続する文字の中で置換可能度の最も小さい文字は、該最も小さい文字に対する認識文字候補の中で、該最も小さい文字の前後の文字に対する認識文字候補のうち最も類似度の高いものに等しい字種であって該最も小さい文字に最も類似するものに等しいと認識する認識修正手段（5）を有する請求項1記載の文字認識装置。

3．発明の詳細な説明

（概　要）

　複数の字種の文字パターンを記憶する辞書を備えて、認識対象の文字列を構成する各文字の形状に関するデータを抽出して前記複数の字種の文字パターンと比較し、該各文字に対する該文字パターンの類似度によって文字を認識する文字認識装

しきい値と比較し、該それぞれに対応するしきい値を基準として、該各文字の置換可能度が小さく、且つ、該前後の文字の置換可能度が大きいという置換可能条件を満たすとき、該各文字は、前記前後の文字に対して最も類似度の高い認識文字候補の字種であるものの中で該各文字に対する類似度が最も高い認識文字候補に等しいと認識し、該置換可能条件を満たさないとき、該各文字は該各文字に対して最も類似度の高い認識文字候補に等しいと認識する認識文字処理手段とを有してなるように構成する。

（産業上の利用分野）

　本発明は、複数の字種の文字パターンを記憶する辞書を備えて、認識対象の文字列を構成する各文字の形状に関するデータを抽出して前記複数の字種の文字パターンと比較し、該各文字に対する該文字パターンの類似度によって文字を認識する文字認識装置に関する。

　通常、文字認識装置においては、紙面上、ある

認に関し、

　同一字種の文字の間に異なる字種の文字が存在する場合に、該異なる字種の文字を該異なる字種の文字の前後の文字と同一字種の文字候補の中で最も類似度の高い文字パターンの文字に置き換えるべきか否かを判定し得るようにすることを目的とし、

　各文字に対して最も類似度の高い認識文字候補の類似度と、各文字に対する認識文字候補のうち該各文字の前後の文字に対して最も類似度の高い認識文字候補に等しい字種であるものの中で類似度が最も高いものの類似度との差を置換可能度として求め、前記前後の文字に対する前記最も類似度の高い認識文字候補の類似度と、該前後の文字に対する認識文字候補のうち前記各文字に対して最も類似度の高い認識文字候補と等しい字種であるものの中で類似度が最も高いものの類似度との差を置換可能度として求める置換可能度演算手段と、前記各文字および該各文字の前後の文字の置換可能度を、それぞれに対応して予め定められた

いは製品上等に印刷された文字や手書きの文字を光学的に走査して画像データとして入力し、あるいは、タブレット等のポインティングデバイス上にペンで記入して座標データとして入力し、その特徴を抽出して予め記憶している所定の（辞書の）文字のパターンと比較し、入力された文字は、最も類似する文字パターンの文字に等しいものとすることにより文字の認識を行なっている。

　上記のような文字認識装置における文字の認識方式には、種々の方式が公知となっている（例えば、特開昭61－86883にまとめられている）が、何れの方式によっても、文字の誤認識の発生は避けることが出来ない。そのため、上記の文字認識の後の段階で誤認識文字の修正の処理が必要となる。

　本発明は、このような文字認識装置における誤認識文字の修正処理に係わるものである。

〔従来の技術、および発明が解決しようとする課題〕

　従来、複数の字種の文字の認識を行なう文字認識装置において行なわれている誤認識の修正方式の1つとして、前述のように、文字列の各文字の画像データを入力して、それぞれを複数字種の辞書の文字のパターンと比較し、最も類似する文字パターンの文字に等しいと認識することにより得られた認識結果が、例えば、「○△○△○△・・・」（ここで○および△は、それぞれ同一字種の文字とする）のようになった場合、1つの単語が異なる字種の文字によって構成されることは少なく、同一の字種の文字の連続によって構成されることが多いことを考慮して、例えば、上記の○の字種の文字であると認識された入力文字データの間に挟まれた△の字種の文字であると認識された入力文字データを、該間に挟まれた文字は、その前後の文字と同一の字種○である可能性が大きいと考えて、該間に挟まれた文字に対して類似する文字パターンのうち、字種○であって最も類似度

の高いものを求めて、これを該間に挟まれた文字に等しいものと認識するように修正する方式がある。

　ところが、従来の上記のようなけ修正方式においては、異なる字種の文字が連続して交互に並ぶような認識結果が得られた場合には、例えば、上記の説明に用いた例において、○の字種の文字の側を修正すればよいのか、△の字種の文字の側を修正すればよいのかを正しく判断することができなかった。

　例えば、第6図は、片仮名で「ハーモニカ」と記された文字画像を読み取って、漢字の辞書と片仮名の辞書とを含む複数の辞書に記憶される文字パターンと比較することによって、類似度の高い認識文字の候補を求めた結果を示すものである。

　第6図において、各認識結果の文字の下に示される数字は、入力画像と認識結果の文字の文字パターンとの類似度を示す指標となる数字であって、第6図の指標が小さい程、類似度は大きい。

　第6図に示されるように、複数の字種の辞書全

てを用いて最も類似度が高い文字パターンの文字を求めた結果は、入力画像「ハ」、「モ」および「カ」に対しては、それぞれ片仮名「ハ」、「モ」および「カ」となったが、入力画像「一」「ニ」に対しては、それぞれ漢字の「一」および「二」となっている。

　ところが、従来の文字認識装置においては、上記のような、「漢字―片仮名―漢字―片仮名―漢字」という結果が得られた際に、漢字と認識された文字の間に挟まれた、片仮名と認識された文字を漢字の中で最も類似度の高い文字パターンの文字と置き換えればよいのか、あるいは、片仮名と認識された文字の間に挟まれた、漢字と認識された文字を片仮名の中で最も類似度の高い文字パターンの文字と置き換えればよいのかが判断出来なかった。そのため、第6図の例で、漢字の「一」および「二」と認識された文字画像を、それぞれ片仮名の中で最も類似度の高い「一」および「ニ」と置き換えれば良いところを、逆に、片仮名「ハ」、「モ」および「カ」と認識した方を、それぞれ、

漢字の中で最も類似度の高い「八」、「壬」および「力」と置き換えてしまい、修正処理の結果が却って悪化するという問題があった。

　本発明は上記の問題点に鑑み、なされたもので、複数の字種の文字パターンを記憶する辞書を用いて、文字列を構成する各文字の画像に対して、それぞれ最も類似度の高い文字パターンの文字を選出した結果、同一字種の文字の間に異なる字種の文字が存在する場合に、該異なる字種の文字を前後の文字と同一の字種の文字候補の中で最も類似度の高い文字パターンの文字に置き換えるべきか否かを判定し得る文字認識装置を提供することを目的とするものである。

〔課題を解決するための手段〕

　第1図は本発明の第1の形態の基本構成図である。本図において、1は辞書部、2は認識文字候補選出手段、3は置換可能度演算手段、そして、4は認識文字処理手段である。

　辞書部1は、複数の字種の文字パターンを記憶

する。

認識文字候補選出手段2は、認識対象の文字列を構成する各文字の形状に関するデータを入力して特徴を抽出し、前記複数の字種の文字パターンと比較して、該各文字に対して類似度の高い文字パターンの文字を認識文字候補として選出する。

置換可能度演算手段3は、前記文字列における該各文字について、該各文字の前後の文字に対して最も類似度の高い認識文字候補の字種が互いに同一の第1の字種(任意の1字種)であり、且つ、該各文字に対して最も類似度の高い認識文字候補の字種が、上記前後の文字に対する最も類似度の高い認識文字候補の字種と異なる第2の字種(前記第1の字種と異なる任意の1字種)である場合に、該各文字に対する前記最も類似度の高い認識文字候補の類似度と、該各文字に対する認識文字候補のうち前記第1の字種であって類似度が最も高いものの類似度との差を置換可能度として求め、前記前後の文字に対する前記最も類似度の高い認識文字候補の類似度と、該前後の文字に対する前

記認識文字候補のうち前記第2の字種であるものの中で類似度が最も高いものの類似度との差を置換可能度として求める。

認識文字処理手段4は、前記各文字および該各文字の前後の文字の置換可能度を、それぞれに対応して予め定められたしきい値と比較し、該それぞれに対応するしきい値を基準として、該各文字の置換可能度が小さく、且つ、該前後の文字の置換可能度が大きいという条件を満たすとき、該各文字は、前記第1の字種であるものの中で類似度が最も高い認識文字候補に等しいと認識し、該条件を満たさないとき、該各文字は前記最も類似度の高い認識文字候補に等しいと認識する。

第2図は本発明の第2の形態の基本構成図である。本図においては、前記第1図の構成に加えて、認識修正手段5が設けられている。

認識修正手段5は、前後の文字に対する最も類似度の高い認識文字候補の字種が互いに同一であり、且つ、自文字に対する最も類似度の高い認識文字候補の字種が、該前後の文字に対する最も類

似度の高い認識文字候補の字種と異なり、さらに、前記置換可能度が前記しきい値以下であるものが2文字以上連続するとき、該連続する文字の中で置換可能度の最も小さい文字は、該最も小さい文字の前後の文字に対する最も類似度の高い認識文字候補と同一の字種であるものの中で該最も小さい文字に対する類似度が最も高い認識文字候補に等しいと認識するものである。

〔作 用〕

本発明の第1の形態によれば、文字列を構成する各文字に対して最も類似する(辞書の)文字パターンの字種が、該各文字の前後の文字に最も類似する文字パターンの字種と異なり、且つ、該前後の文字に最も類似する文字パターンの字種が互いに等しいときに、上記各文字、すなわち、中心の文字を、上記前後の文字に等しい字種のものの中で該中心の文字に最も類似する文字パターンの文字に等しいと認識するか否かを判定する手段として、辞書の文字パターン全てと比較したときに

該中心の文字に対して最も類似する文字パターンの類似度と、上記前後の文字に等しい字種のものの中で該中心の文字に最も類似する文字パターンの類似度との差を求めることにより、上記辞書の文字パターン全てと比較したときに該中心の文字に対して最も類似する文字パターンの文字が、該中心の文字に対する文字認識として、どれだけ確からしいか(文字認識の確実度)の指標が得られる。

同時に、上記前後の文字についても同様に、文字認識の確実度の指標を求める。

こうして、該中心の文字に対する文字認識の確実度の指標(置換可能度)が予め定めたしきい値より小さく、且つ、上記前後の文字に対する文字認識の確実度の指標(置換可能度)が予め定めたしきい値より大きいとき(置換可能条件)には、前述のように、文字列においては同一の字種の文字が連続する可能性が大きいという点を考慮して、前記辞書の文字パターン全てと比較したときに該中心の文字に対して最も類似する文字パターンの

文字が該中心の文字に対する文字認識としては誤認識である可能性が高いと判断して、上記前後の文字に最も類似する文字パターンに等しい字種であって該中心の文字に対して最も類似する文字パターンの文字を該中心の文字に対する文字認識として採用する。

こうして、複数の字種の文字パターンを記憶する辞書を用いて、文字列を構成する各文字の画像データあるいは、座標データに対して、それぞれ最も類似度の高い文字パターンの文字を選出した結果、同一字種の文字の間に異なる字種の文字が存在する場合に、該異なる字種の文字を前後の文字の字種と同一字種の文字パターンの中で最も類似度の高い文字パターンの文字に置き換えるべきか否かを判定することができ、修正処理の結果が却って悪化するということを、かなり防止できる。

また、本発明の第2の形態によれば、上述の本発明の第1の形態における置換可能度が前記所定のしきい値以下であるにも拘わらず、前記辞書の文字パターン全てと比較したときに該中心の文字

に対して最も類似する文字パターンの字種が、前後の文字に対して最も類似する文字パターンの字種と異なるものが2つ以上連続して存在するときには、この連続して存在する文字の中で、前記文字認識の確実度の指標（置換可能度）が最も小さいものが誤認識である可能性が高いと判断して、該前後の文字に最も類似する文字パターンに等しい字種であって上記の確実度の指標（置換可能度）が最も小さい文字に対して最も類似する文字パターンの文字を該最も小さい文字に対する文字認識として採用する。

こうして、本発明の第2の形態によれば、より精度のよい修正処理が可能となる。

〔実施例〕

本発明の実施例の文字認識装置のハードウェア構成は、概略、従来のOCR (optical code reader) やオンライン手書き文字認識等の文字認識装置と同様であって、第3図に示されるように、認識辞書30、入力部31、特徴抽出部32、照

合部33、後処理部34、そして、表示部35からなる。

入力部31は文字の画像データを光学的に読み取る。あるいは、タブレット上に片で記入された文字の座標を読み取る。

特徴抽出部32は、前述のような種々の認識方式に従う文字パターンを特徴づけるパラメータの抽出を行なう。

認識辞書30は、上記の認識方式に従う標準文字パターンを記憶する。前述のように、本発明の実施例の文字認識装置においては、片仮名、平仮名、漢字等、複数の字種の標準文字パターンを記憶する。

照合部33は、前記特徴抽出部32において抽出した文字パターンの特徴パラメータを、上記認識辞書30に記憶する全ての字種の標準文字パターンと比較して、各入力文字に対して、類似度の高いものから順に、その類似度と共にリストアップして認識文字候補列を生成する。

そして、後処理部34においては、前記照合部

33において類似度が第1位と判定された認識文字候補を最終的な文字認識結果として採用してよいかどうかを判定し、その判定に従って必要ならば、前記認識文字候補列のより下位の認識文字候補を最終的な文字認識結果として採用する。すなわち、前述の本発明の特徴的な構成は、主にこの後処理部34に存在する。

そして、表示部35は、上記の後処理部34より出力された最終的な文字認識結果を表示する。

なお、上記の認識辞書30は、主としてメモリ回路からなり、入力部31が、例えば、通常のOCRにおけるような光学的な走査機構（例えば、CCDスキャナ等）、あるいは、タブレット等の座標入力機構を備え、表示部35がCRT等の表示機構を備える他は、上記各部は、それぞれ、CPU、RAM、ROM等から構成されるマイクロコンピュータによって実現される。

第3図の構成中、本発明に係わる後処理部34の構成の概略は、第6図に示されている。すなわち、後処理部は、制御部40、字種判定部41、

候補検索部４２、類似度差算出部４３、置換可能値保存部４４、そして、置換処理部４５からなる。

制御部４０は、第３図の照合部３３において、入力された文字画像の各々について前述の認識文字候補列が生成されると、字種判定部４１を制御して、該認識文字候補列の第１位の候補の字種の判定が行なわれるように指示する。字種判定部４１は該認識文字候補列の第１位の候補の字種が、前後の文字同士は互いに同じであって、該前後の文字の間に位置する中心の文字のみ該前後の文字の字種と異なるとき、該中心の文字を置換検討文字と判定する。候補検索部４２は、上記字種判定部４１において置換検討文字と判定された文字については、該置換検討文字と判定された文字の前後の文字に対する認識文字候補列の第１位の候補と等しい字種の認識文字候補のうち最も類似度の高いものを検索し、また、該前後の文字については、上記置換検討文字と判定された文字に対する認識文字候補列の第１位の候補と等しい字種の認識文字候補のうち最も類似度の高いものを検索す

る。ここで入力された先頭の文字の前の文字に対する認識文字候補としては、２文字目の文字に対する認識文字候補の字種を、また、末尾の文字の後の文字に対する認識文字候補としては、末尾から２番目の文字に対する認識文字候補の字種を用いる。

そして、類似度差算出部４３は、前記候補検索部４２において検出された、置換検討文字および該置換検討文字の前後の文字に対する認識文字候補列の第１位の候補とその類似度、および、上記置換検討文字と判定された文字の認識文字候補のうち、該置換検討文字の前後の文字に対する認識文字候補列の第１位の候補と等しい字種であって該置換検討文字と判定された文字に対する類似度が最も高いものとその類似度、そして、上記置換検討文字と判定された文字の前後の文字の認識文字候補のうち、該置換検討文字と判定された文字に対する認識文字候補列の第１位の候補と等しい字種であって該前後の文字に対する類似度が最も高いものとその類似度をもとに、

（置換検討文字の置換可能度）＝｜（置換検討文字と判定された文字に対する認識文字候補列の第１位の候補の類似度）－（該置換検討文字と判定された文字の認識文字候補のうち該置換検討文字と判定された文字の前後の文字に対する認識文字候補列の第１位の候補と等しい字種であって該置換検討文字と判定された文字に対する類似度が最も高いものの類似度）｜

（前後の文字の置換可能度）＝｜（置換検討文字と判定された文字の前後の文字に対する認識文字候補列の第１位の候補の類似度）－（置換検討文字と判定された文字の前後の文字に対する認識文字候補列のうち該置換検討文字と判定された文字に対する認識文字候補列の第１位の候補と等しい字種であって該前後の文字に対する類似度が最も高いものの類似度）｜

を演算して求める。

例えば、上記置換検討文字およびその前後の文字に対する認識文字候補列の第１位の候補の字種が「○△○」となったときには、上記置換検討文

字の前の文字に対する認識文字候補列の第１位の候補の類似度と、該前の文字に対する認識文字候補列内の、字種△であって該前の文字に対する類似度が最も高い候補の類似度との差（の絶対値）を求め、これをd_1とする。

同様に、上記置換検討文字に対する認識文字候補列の第１位の候補の類似度と、該置換検討文字に対する認識文字候補列内の、字種○であって該置換検討文字に対する類似度が最も高い候補の類似度との差（の絶対値）を求め、これをd_2とする。

さらに、上記置換検討文字の後の文字に対する認識文字候補列の第１位の候補の類似度と、該後の文字に対する認識文字候補列内の、字種△であって該後の文字に対する類似度が最も高い候補の類似度との差（の絶対値）を求め、これをd_3とする。

なお、上記置換検討文字あるいは前後の文字の何れかについて、上記のように、認識文字候補列内の、より下位に異なる字種の認識文字候補が存

在しないときには、対応する類似度の差（の絶対値）の代わりに、後述する対応するしきい値を超える所定の値に設定する。

上記の演算結果は、第4図の置換検討文字データ保持部44に保持される。

第4図の置換処理部45は、上記置換検討文字データ保持部44に保持されたデータをもとに以下の処理を行なう。

まず、上記置換可能度を、置換検討文字および該置換検討文字の前後の文字それぞれに対応して予め設定されたしきい値と比較して、前述の本発明による置換可能条件を満たすか否かを判定する。

すなわち、前述の例において、前記前の文字、置換検討文字、および後の文字に対して予め定められたしきい値を、それぞれ、TH1，TH2，およびTH3とするとき、置換可能条件 $d_1 >$ TH1．$d_2 <$ TH2．および $d_3 >$ TH3を同時に満たすかどうかを判定する。

もし、上記置換可能条件を満たすならば、該置換検討文字を、上記の置換検討文字に対する認識

文字候補列内の、字種〇であって該置換検討文字に対する類似度が最も高い候補、つまり、該置換検討文字の認識文字候補のうち置換検討文字の前後の文字に対する認識文字候補列の第1位の候補と等しい字種であって該置換検討文字に対する類似度が最も高い候補に等しいと認識する。すなわち、置換が行なわれる。

上記の置換可能条件を満たさないときには、該置換検討文字は、元の該置換検討文字に対する認識文字候補列内の第1位の候補と等しいと認識する。すなわち、置換は行なわれない。

ところで、例えば、前述のように、字種が「〇△〇△」のように連続したときに、さらに、これらの2番目および3番目の文字の上記置換可能度が前記のしきい値以下である場合を考える。さらに、このような場合に、置換可能度が前記のしきい値以下であるために置換が行なわれなかった置換検討文字が2つ以上連続したとき、前述の本発明の第2の形態によって設けられた、認識修正手段5（第2図）に対応する機能が働く。

すなわち、連続する3文字の中に置換が行なわれなかった置換検討文字が2つ以上連続して存在するときには、該連続する置換検討文字のうち、前記置換可能度が最小となる文字は、該置換可能度が最小となる文字の認識文字候補列内の、該置換可能度が最小となる文字の前後の文字に対する認識文字候補列内の第1位の候補と等しい字種のものの中で該最小となる文字に対する類似度が最も高い候補に等しいと認識する。つまり、上記連続する置換検討文字のうち、前記置換可能度が最小となる文字に対して置換を実行する。

上述の置換処理部45による処理を、第3図の照合部33において前記第6図の認識結果が得られた場合を例にとって以下に具体的に説明する。

第6図には、また、第6図の認識結果から演算される置換可能度を、入力「ハ」に対応する文字、入力「ー」に対応する文字、そして、入力「モ」に対応する文字について、それぞれ示している。

前述のように、第6図の認識結果（認識文字候補列）の第1位の字種は、「〇△〇△△」となっ

ており、例えば、第1〜3番目まで全て前記置換検討文字である。ここで、さらに、前記のしきい値TH1，TH2およびTH3を全て50であるとすると、第6図に示されるように、全ての文字に対する置換可能度が該しきい値50以下である。したがって、何れの場合にも、本発明の第1の形態による置換可能条件を満たさず、該置換可能条件による置換は行なわれない。

そこで、次に、本発明の第2の形態による認識修正手段の機能が働く。

今、置換検討文字として抽出され、置換条件を満たしていると判定された「ハ」、「ー」、「モ」の置換可能度を比較すると、「ー」の置換可能度3が最小である。したがって、「ー」について、本発明の第2の形態による認識修正手段の機能によって、置換が行なわれる。

上述の入力「ー」に対応する文字の置換とは、すなわち、該入力「ー」に対応する文字に対する認識文字候補列の第1位にある漢字「一」という認識を、該入力「ー」に対応する文字に対する認

識文字候補列において、該入力「ー」に対応する文字の前後の文字に対する認識文字候補列の第1位の字種と同一の字種、つまり、片仮名であるものの中で最も該入力「ー」に対応する文字に類似するところの、第3位の片仮名「ー」に置き換えるものである。こうして、元の片仮名の入力「ハーモ」の部分が正しく認識された。

　このようにして、本発明の実施例の第3図および第4図の構成によれば、片仮名の入力「ハーモニカ」に対して認識結果「ハーモ二力」（「二」および「力」は漢字）が表示される。

　第5図は、以上述べた本発明の実施例の処理の手順をフローチャートにより示すものである。

　第5図のステップ500の開始後、ステップ501にて、先ず先頭文字を中心文字として、ステップ502にて、該中心文字および該中心文字の前後の文字に対する認識文字候補列（例えば、第6図）の第1位の候補の字種を検出し、ステップ503にて、該前後の文字に対する認識文字候補列の第1位の候補の字種が同一の字種であって

該中心文字に対する認識文字候補列の第1位の候補の字種と異なる（すなわち、該中心文字が置換検討文字である）ならばステップ504に進む。ステップ503において上記以外の場合にはステップ508に進んで入力文字列の次の文字を中心文字とし、ステップ502に進む。

　前記ステップ504にては、前記中心文字に対する認識文字候補列において、該中心文字の前後の文字に対する認識文字候補列の第1位の候補と等しい字種の候補の中で該中心文字に最も類似する候補、および、前記中心文字の前後の文字に対する認識文字候補列において、該中心文字に対する認識文字候補列の第1位の候補と等しい字種の候補の中で該前後の文字に最も類似する候補を検索する。

　ステップ505においては、前記中心文字に対して、該中心文字に対する認識文字候補列の第1位の候補の類似度と、該中心文字に対する認識文字候補列において該中心文字の前後の文字に対する認識文字候補列の第1位の候補と等しい字種の

候補であって該中心文字に最も類似する候補の類似度との差を置換可能度として求め、また、前記中心文字の前後の文字に対して、該中心文字の前後の文字に対する認識文字候補列の第1位の候補の類似度と、該中心文字の前後の文字に対する認識文字候補列において該中心文字に対する認識文字候補列の第1位の候補と等しい字種の候補であって該中心文字の前後の文字に最も類似する候補の類似度との差を置換可能度として求める。

　ステップ506においては、上記の置換可能度のデータを（第4図の置換検討文字データ保持部44に）記憶する。

　以上の処理が入力文字列の全ての文字を中心文字として実施されたか否かをステップ507にて判断し、全ての文字について処理が終了していなければ再び前記ステップ508に進み、終了していればステップ509に進む。

　ステップ509〜514は、前記入力文字列の全ての文字を中心文字とした場合について、それぞれ、前記置換可能条件 $d_1 > TH1$, $d_2 <$

$TH2$, および $d_3 > TH3$ を同時に満たすかどうかを判定し、該置換可能条件を満たせばステップ512において、そのときの中心文字を、該中心文字に対する認識文字候補列の第1位の候補の代わりに、該中心文字に対する認識文字候補列において該中心文字の前後の文字に対する認識文字候補列の第1位の候補と等しい字種の候補であって該中心文字に最も類似する候補に等しいと認識する。

　ステップ513にては、以上の処理が入力文字列の全ての文字を中心文字として実施されたか否かを判断し、全ての文字について処理が終了していればステップ515に進む。

　ステップ515〜525は、前記入力文字列の全ての文字について、置換可能度がしきい値以下である置換検討文字が2文字以上連続して存在するか否かを判定し、さらに、該中心文字が、上記2文字以上連続して存在する、置換可能度がしきい値以下である置換検討文字のうち、置換可能度（前記類似度の差）が最小の文字については、そ

の文字に対する認識文字候補列の第1位の候補の代わりに、該文字に対する認識文字候補列において該文字の前後の文字に対する認識文字候補列の第1位の候補と等しい字種の候補であって該文字に最も類似する候補に等しいと認識する手順を示すものである。

すなわち、ステップ515〜517において先頭文字から順に、置換可能度がしきい値以下である置換検討文字をサーチして、もし、置換可能度がしきい値以下である置換検討文字が存在すれば、ステップ518および519にて、次の文字も置換可能度がしきい値以下である置換検討文字かどうかを判定する。そして、ステップ519において、置換可能度がしきい値以下である置換検討文字が2文字続いたと判断されたときは、ステップ520および521に進んで、置換可能度がしきい値以下である置換検討文字がどこまで連続するかを検出し、ステップ522において、これら連続する置換可能度がしきい値以下である置換検討文字のうち置換可能度（前記類似度の差）が最小

の文字を求め、さらに、ステップ523において、該置換可能度が最小の文字については、その文字に対する認識文字候補列の第1位の候補の代わりに、該文字に対する認識文字候補列において該文字の前後の文字に対する認識文字候補列の第1位の候補と等しい字種の候補であって該文字に最も類似する候補に等しいと認識する。すなわち、置換を行なう。

そして、ステップ524にては、以上の処理が入力文字列の全ての文字について実施されたか否かを判断し、全ての文字について処理が終了していればステップ521に進んで処理を終了する。

〔発明の効果〕

本発明によれば、同一字種の文字の間に異なる字種の文字が存在する場合に、該異なる字種の文字を、該異なる字種の文字の前後の文字と同一字種の文字候補の中で最も類似度の高い文字パターンの文字に置き換えるべきか否かを判定し得るようにし、文字認識装置における修正処理の性能を

改善することができる。

4. 図面の簡単な説明

第1図は本発明の第1の形態の基本構成図、

第2図は本発明の第2の形態の基本構成図、

第3図は文字認識装置のハードウェア構成の概略を示す図、

第4図は第3図の構成における後処理部の構成の概略を示す図、

第5図は本発明の実施例における処理の手順を示す図、そして

第6図は第3図の文字認識装置の照合部による認識結果の1例を示す図である。

（符号の説明）

1…辞書部、
2…認識文字候補選出手段、
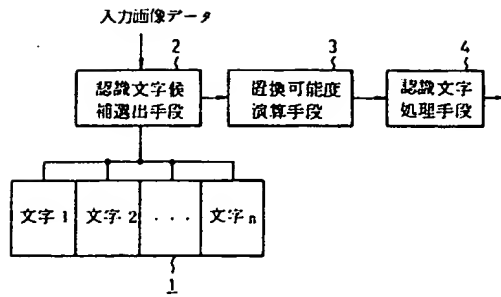3…置換可能度演算手段、そして、
4…認識文字処理手段、5…認識修正手段、
30…認識辞書、　31…入力部、
32…特徴抽出部、　33…照合部、
34…後処理部、　35…表示部、
40…制御部、　41…字種判定部、
42…候補検索部、　43…類似度差算出部、
44…置換可能値保存部、
45…置換処理部。

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特許出願代理人
弁理士　青木　　朗
弁理士　石田　　敬
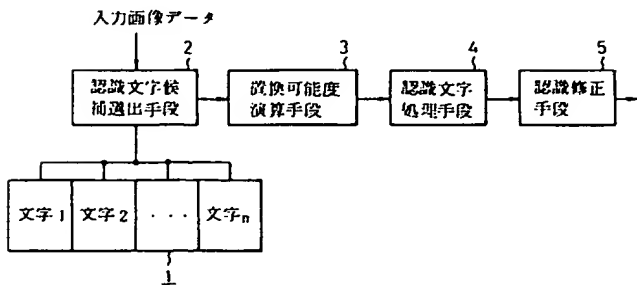弁理士　平岩賢三
弁理士　山口昭之
弁理士　西山雅也

第 1 図

入力画像データ

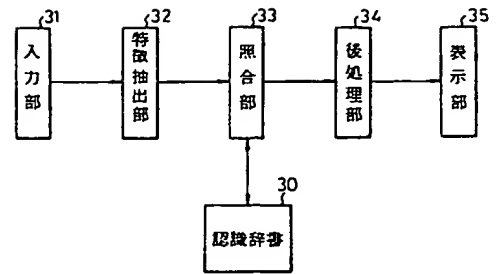| 認識文字候補選出手段 2 | 変換可能度演算手段 3 | 認識文字処理手段 4 |

| 文字1 | 文字2 | ... | 文字n |

1

本発明の第1の形態の基本構成図

第 2 図

入力画像データ

| 認識文字候補選出手段 2 | 変換可能度演算手段 3 | 認識文字処理手段 4 | 認識修正手段 5 |

| 文字1 | 文字2 | ... | 文字n |

1

本発明の第2の形態の基本構成図

第 3 図

| 入力部 31 | 特徴抽出部 32 | 照合部 33 | 後処理部 34 | 表示部 35 |

認識辞書 30

文字認識装置のハードウェア構成の概略を示す図

第 4 図

| 制御部 40 | 字種判定部 41 | 候補検索部 42 | 類似度差演算出部 43 | データ保持部 44 | 置換対象文字 | 置換処理部 45 |

表示部へ
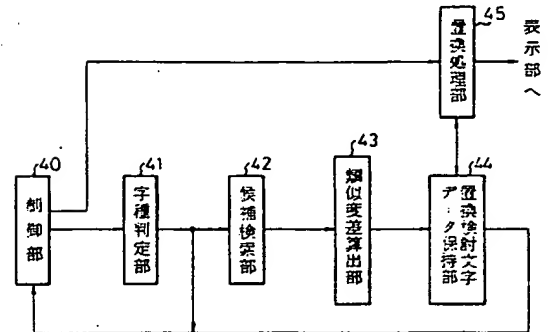
本発明の実施例の文字認識装置における後処理部の構成の概略を示す図

第 5 図

本発明の実施例における処理の手順を示す図

開始 500

中心文字 ← 先頭文字 501

類似度第1位の文字およびその字種判定 502

前後文字との字種比較 503 — 異字種 / 同字種

当該文字と前後の文字の類似度第2位以下の異字種の検索 504

類似度第1位の文字と類似度第2位以下の異字種の文字との類似度の差 505

文字番号、類似度および類似度の差を記録 506

全文字終了？ 507 — NO / YES

中心文字 ← 次文字 508

中心文字 ← 先頭文字 509

類似度の差をしきい値と比較 510

d1 >TH1
d2 <TH2
d3 >TH3
511 — NO / YES

中心文字を類似度第2位以下の異字種文字に置換する 512

全文字終了？ 513 — YES / NO

中心文字 ← 次文字 514

先頭文字 515

しきい値以下の変換検討文字？ 516 — NO / YES 次文字

しきい値以下の変換検討文字？ 519 — NO / YES 次文字 520

しきい値以下の変換検討文字？ 521 — YES / NO

ステップ522へ

ステップ521より

連続するしきい値以下の変換検討文字のうち類似度の差が最小の文字を求める 522

類似度の差が最小の文字を類似度第2位の異字種文字に置換する 523

全文字終了？ 524 — NO / YES

終了 525

入力文字

ハ 一 モ ニ カ

	ハ (カタカナ) 45	一 (漢字) 6	モ (カタカナ) 79	二 (漢字) 8	カ (漢字) 17
1 位	ハ (カタカナ) 45	一 (漢字) 6	モ (カタカナ) 79	二 (漢字) 8	カ (漢字) 17
2 位	い (ひらがな) 81	一 (ひらがな) 6	も (ひらがな) 108	二 (カタカナ) 15	カ (カタカナ) 28
3 位	八 (漢字) 94	一 (カタカナ) 9	壬 (漢字) 117	Z (英大字) 127	刀 (漢字) 40
4 位	入 (漢字) 116		巳 (漢字) 155	こ (ひらがな) 138	九 (漢字) 116

置換可能度 ——→ 49　　　3　　38　　7　　11

照合部による認識結果を示す図

第 6 図

CHARACTER RECOGNITION DEVICE

Yukiko Yamaguchi

JAPANESE PATENT OFFICE
PATENT JOURNAL (A)
KOKAI PATENT APPLICATION NO. HEI 2[1990]-58187

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CHARACTER RECOGNITION DEVICE

[Monji ninshiki sochi]

Inventor:	Yukiko Yamaguchi
Applicant:	Fujitsu Ltd.

[There are no amendments to this patent.]

Claims   /1*

1. A character recognition device characterized by the fact that it comprises the following parts:

dictionary (1) that stores the character patterns of a plurality of character types;

recognized character candidate selecting means (2) that has the data pertaining to the shapes of the characters that form the character string as the recognition object, extracts characteristic features, compares them with the character patterns of said a plurality of character types, and selects the characters of the character pattern with the high resemblance to said characters as the recognized character candidates;

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* [Numbers in the margin represent pagination in the original text.]

substitution possibility computing means (3) that performs the following operation: for each specific character in said character string, when the character types of the recognized character candidates with the greatest resemblance to the characters preceding and following said specific character are of the same first character type, and the character type of the recognized character candidate with the greatest resemblance to said specific character is of a second character type different from the character type of the recognized character candidates with the greatest resemblance to said preceding and following characters, the difference between the resemblance of said recognized character candidate with the greatest resemblance to said specific character and the resemblance of the recognized character candidate of the first character type with the greatest resemblance to said specific character out of said recognized character candidates is regarded as a substitution possibility, and the difference between the resemblance of the recognized character candidate with the greatest resemblance to said preceding and following characters and the resemblance of the recognized character candidate of the second character type with the greatest resemblance out of said recognized character candidates with respect to said preceding and following characters is regarded as a substitution possibility;

and recognized character processing means (4) that performs the following operation: the substitution possibilities of said specific character and said characters preceding and following said specific character are compared with the prescribed thresholds, and, when the substitution possibility condition is met, that is, when the substitution possibility of said specific character is small and the substitution possibility of the preceding and following characters is large with respect to the given thresholds as references, said specific character is recognized as being identical to the recognized character candidate with the greatest resemblance to said specific character out to said recognized character candidates of said first character type, and when said substitution possibility condition is not met, said specific character is recognized as being identical to the recognized character candidate with the greatest resemblance.

2. The character recognition device described in Claim 1 characterized by the fact that it comprises recognition correcting means (5) that performs the following operation: when the character types of the recognized character candidates with the greatest resemblance to said preceding and following characters are of the same character type and the character type of the recognized character candidate with the greatest resemblance to the specific character is of a character type different from the character type of the recognized character candidates with the greatest resemblance to the preceding and following characters, and there exist two or more characters having said substitution possibility of said specific character below said threshold, it is recognized that the character with the least substitution possibility out of said continuous characters is identical to the recognized character candidate of the same character type as that with the greatest resemblance among the recognized character candidates to the characters

/2

preceding and following said character with the smallest substitution possibility and with the greatest resemblance to said character with the smallest substitution possibility.

Detailed explanation of the invention
Abstract

The present invention pertains to a character recognition device, which has a dictionary that stores character patterns of various character types, and which extracts the data pertaining to the shape of each of the characters that form the character string as the recognition object, compares with the character patterns of said a plurality of character types, and recognizes each specific character by means of the resemblance of the character pattern to said specific character.

The purpose of the present invention is as follows: when there exists a character of a character type different from that of characters of a certain character type, it is possible to determine whether said character of the different character type should be replaced with the character of the character pattern with the greatest resemblance out of the character candidates of the same character type as that of the characters preceding and following said character of the different character type.

It comprises the following means: a substitution possibility computing means that finds: the difference between the resemblance of said recognized character candidate with the greatest resemblance to said specific character and of the same character type as that of the recognized character candidates with the greatest resemblance to the characters preceding and following said specific character among the recognized character candidates for the specific character is determined as the substitution possibility, and the difference between the resemblance of the recognized character candidate with the greatest resemblance to said preceding and following characters and the resemblance of the recognized character candidate with the greatest resemblance to said preceding and following characters and of the same character type as that of the recognized character candidate with the greatest resemblance to said specific character among the recognized character candidates with respect to said preceding and following characters is determined as the substitution possibility; and a recognized character treatment means that performs the following operation: the substitution possibilities of said specific character and said characters preceding and following said specific character are compared with the prescribed thresholds, and when the substitution possibility condition is met, that is, when the substitution possibility of said specific character is small and the substitution possibility of the preceding and following characters is large with respect to the respective thresholds, said specific character is recognized as equal to the recognized character candidate with the greatest resemblance to said specific character among said recognized character candidates of the character type of the recognized character candidates with the greatest resemblance to said

preceding and following characters, and when said substitution possibility condition is not met, said specific character is recognized as equal to the recognized character candidate with the greatest resemblance to said specific character.

Industrial application field

The present invention pertains to a character recognition device, which has a dictionary in which character patterns of various character types are stored and which extracts data pertaining to the shape of each of the characters that form the character string to be recognized, compares with the character patterns of said a plurality of character types, and recognizes each specific character by means of the resemblance of the character pattern with respect to said specific character.

Usually, for a character recognition device, characters printed on a paper sheet or other material, or handwritten characters are optically scanned, and the obtained image data is input. Or, characters may be written with a pen on a tablet or other pointing device so that they are input as coordinate data. The characteristics are extracted and compared with the pre-stored prescribed patterns of characters (of a dictionary), and the input character is taken as equal to the character of a character pattern most similar to the input character. In this way, character recognition is performed.

Various conventional schemes have been proposed for recognition of characters in said character recognition device (for example, as those described in Japanese Kokai Patent Application No. Sho 61[1986]-86883). However, in all of the conventional methods, it is impossible to avoid generation of erroneous recognition of characters. Consequently, after said character recognition, it is necessary to perform correction for the erroneously recognized characters.

The present invention pertains to a correction treatment for erroneously recognized characters in said character recognition device.

Prior art and problems to be solved by the invention /3

The following is a correction system for erroneous recognition performed with a character recognition device that performs recognition of characters in a plurality of character types. As explained above, the image data of each specific character of a character string is input and is compared with the patterns of characters in the dictionary of a plurality of character types, and the character is recognized as the character of a character pattern with the greatest resemblance. For example, when the result of recognition is "O Δ O Δ O Δ ..." (here, O and Δ each represent the characters of the same character type), in consideration of the fact that in few cases, a single word is composed of characters of different character types, and it usually is

composed of a continuous string of characters of the same character type. For example, for the input character data recognized as characters of the character type of Δ sandwiched between characters of said character type of O, it is quite possible that it is of the same type of O as the preceding and following characters. Consequently, correction is carried out by determining the character pattern of character type O and with the greatest resemblance among the character patterns similar to the character sandwiched between the preceding and following characters, and taking it as the character sandwiched between the preceding and following characters.

However, for the aforementioned conventional correction system, when a recognition result of a character string with characters of different character types set alternately and side-by-side is obtained, it is impossible to make a correct judgment on whether correction should be made to the side of the characters of O type or the side of the characters of Δ type in the aforementioned example.

For example, Figure 6 is a diagram illustrating the result obtained by determining the recognized character candidates with high resemblance when a character image of "HA A MO NI KA" [in Japanese characters] is read and comparison is made with the character patterns stored in a plurality of dictionaries, including a Kanji dictionary and a dictionary of Japanese characters.

As shown in Figure 6, the figure below each character as recognition result represents the index indicating the resemblance between the input image and the character pattern of the character as the recognition result. The smaller the index of Figure 6, the larger the resemblance.

As shown in Figure 6, the result of determination of the characters with character patterns with the greatest resemblance by using all of the dictionaries of a plurality of character types indicates that although for the input images of "HA", "MO" and "KA", the Japanese characters of "HA", "MO" and "KA" are obtained, respectively, for input images "A" and "NI" [「ー」 「ニ」] , Kanji "ONE" [「ー」] and "TWO" [「ニ」] are obtained.

For the conventional character recognition device, when said result of "Kanji-Japanese character-Kanji-Japanese character-Kanji" is obtained, it is impossible to judge whether the character sandwiched between characters recognized as Kanji and recognized as Japanese character should be replaced with the character pattern with the greatest resemblance among the Kanji, or the character sandwiched between characters recognized as Japanese characters and recognized as Kanji should be replaced with the character pattern with the greatest resemblance among the Japanese characters. Consequently, in the example shown in Figure 6, one may either substitute the character images recognized as Kanji "ONE" and "TWO" with the Japanese characters with the greatest resemblance, that is, "A" and "NI", or, on the contrary, one may substitute the characters recognized as Japanese characters "HA", "MO" and "KA" with the Kanji with the greatest resemblance, that is, "EIGHT" [「八」], "NINTH" [「九」] and "FORCE"

[「カ」], respectively. In the latter case, the correction treatment result is worse than that before correction. This is undesirable.

The purpose of the present invention is to solve the aforementioned problems of the prior art by providing a type of character recognition device characterized by the fact that it makes use of a dictionary storing character patterns of a plurality of character types to select the character of a character pattern with the greatest resemblance to the image of each of the characters that form the character string, and, as a result of said selection, when there exists a character of a character type different from the preceding and following characters of a prescribed character type, it can judge whether the character of the different character type should be replaced with a character of a character pattern with the greatest resemblance among the character candidates of the same character type as that of the preceding and following characters.

Means to solve the problems

Figure 1 is a diagram illustrating the basic constitution of Embodiment 1 of the present invention. In this figure, (1) represents a dictionary; (2) represents a recognized character candidate selecting means; (3) represents a substitution possibility computing means; and (4) represents a recognized character treatment means.

Dictionary (1) stores the character patterns of a plurality of character types.

Recognized character candidate selecting means (2) has the data pertaining to the shape of each of the characters that form the character string of the recognition object input to it and extracts the characteristic features, and it compares it with the character patterns of said a plurality of character types, and selects the characters of the character patterns with the greatest resemblance to each specific character as the recognized character candidates.

Substitution possibility computing means (3) performs the following operation: for each specific character in said character string, when the character types of the recognized character candidates with the greatest resemblance to the characters preceding and following said specific character are of the same first character type (any one character type), and the character type of the recognized character candidate with the greatest resemblance to said specific character is of a second character type (any one character type different from said first character type) different from the character type of the recognized character candidates with the greatest resemblance to said preceding and following characters, the difference between the resemblance of said recognized character candidate with the greatest resemblance to said specific character and the resemblance of the recognized character candidate of the first character type with the greatest resemblance to said specific character among said recognized character candidates is determined as the substitution possibility, and the difference between the resemblance of the recognized character candidate with the greatest resemblance to said preceding and following characters and

the resemblance of the recognized character candidate of the second character type with the greatest resemblance among said recognized character candidates with respect to said preceding and following characters is determined as the substitution possibility.

Recognized character treatment means (4) performs the following operation: the substitution possibilities of said specific character and said characters preceding and following said specific character are compared with the prescribed thresholds, and when the substitution possibility condition is met, that is, when the substitution possibility of said specific character is small and the substitution possibility of the preceding and following characters is large with respect to the respective thresholds as references, said specific character is recognized as equal to the recognized character candidate with the greatest resemblance to said specific character among said recognized character candidates of said first character type, and when said substitution possibility condition is not met, said specific character is recognized as equal to the recognized character candidate with the greatest resemblance.

Figure 2 is a diagram illustrating the basic constitution of Embodiment 2 of the present invention. In this figure, in addition to the constitution of said Figure 1, recognition correcting means (5) is set.

Recognition correcting means (5) performs the following operation: when the character types of the recognized character candidates with the greatest resemblance to said preceding and following characters are of the same character type, the character type of the recognized character candidate with the greatest resemblance to the specific character is of a character type different from the character type of the recognized character candidates with the greatest resemblance to the preceding and following characters, and there exist two or more characters having said substitution possibility of said specific character smaller than said threshold, it is recognized that the character with the smallest substitution possibility among said continuous characters is equal to the recognized character candidate of the same character type as that with the greatest resemblance among the recognized character candidates to the characters preceding and following said character with the smallest substitution possibility and with the greatest resemblance to said character with the smallest substitution possibility.

Operation

According to said Embodiment 1 of the present invention, for each of the characters that form the character string, when the character types of the character patterns (of the dictionary) with the greatest resemblance to the specific character are different from the character type of the character patterns with the greatest resemblance to the characters preceding and following said specific character, and the character types of the character patterns with the greatest resemblance to said preceding and following characters are of the same type, for said each character, that is,

the character at the center, as a means to judge whether it should be recognized as equal to the character of the character pattern with the greatest resemblance to said central character among the characters of the character type equal to that of said preceding and following characters, when comparison is made with all of the character patterns of the dictionary, the difference between the resemblance of the character pattern with the greatest resemblance to the central character and the resemblance of the character pattern with the greatest resemblance to the central character among those of the same character type as that of the preceding and following characters is determined so as to obtain an index of the degree of reliability (reliability of character recognition) when the character of the character pattern with the greatest resemblance to the central character is taken as the character recognition for the central character as comparison is performed for all of the character patterns in said dictionary.

At the same time, in the same way as aforementioned, for said preceding and following characters, the index of reliability of character recognition is also determined.

In this way, when the index of reliability of the character recognition for the central character (substitution possibility) is smaller than a prescribed threshold, and the index of the reliability of character recognition (substitution possibility) for said preceding and following characters is larger than a prescribed threshold (substitution possibility condition), as explained above, in consideration of the fact that the character string is quite possibly a continuous string of characters of the same character type, it is judged that when comparison is made with all of the character patterns in the dictionary, the character recognition for the central character with the greatest resemblance to the central character is quite possibly an erroneous recognition. /5 Consequently, the character of the character pattern with the greatest resemblance to the central character and of the same character type as that of the character patterns with the greatest resemblance to said preceding and following characters is adopted as the character recognition for said central character.

In this way, a dictionary that stores character patterns of a plurality of character types is used, and for the image data or coordinate data for each of the characters that form a character string, the character of the character pattern with the greatest resemblance to it is selected. As a result, when a character of a character type different from that of the preceding and following characters of a certain character type is present, it is possible to judge whether said character of a different character type should be replaced with a character of a character pattern with the greatest resemblance among the character patterns of the same character type as that of the preceding and following characters. As a result, it is possible to prevent the result of correction treatment from becoming worse instead of improving.

According to Embodiment 2 of the present invention, although the substitution possibility in said Embodiment 1 of the present invention is lower than said prescribed threshold, when

comparison is made with all of the character patterns of said dictionary, it is found that there are two or more characters of the character patterns with the greatest resemblance to said central character of a character type different from the character patterns with the greatest resemblance to the preceding and following characters, it is judged that in the continuous characters, the character with the smallest index of reliability of said character recognition (substitution possibility) may quite possibly be an erroneous recognition, and the character of a character pattern with the greatest resemblance to the character having the smallest index of reliability (substitution possibility) and of the same character type as that of the character patterns with the greatest resemblance to the preceding and following characters is adopted as the character recognition for the character with the smallest substitution possibility.

In this way, according to Embodiment 2 of the present invention, it is possible to realize correction treatment with a higher precision.

Application examples

Generally speaking, the constitution of the hardware of the character recognition device in the application examples of the present invention is the same as that of the conventional OCR (optical code reader), online handwritten character recognition, and other conventional character recognition devices. As shown in Figure 3, it is composed of recognition dictionary (30), input part (31), characteristics extracting part (32), comparing part (33), post-treatment section part (34), and display (35).

Input part (31) reads the image data of the character. In another scheme, it reads the coordinates of the character written on a tablet.

Characteristics extracting part (32) extracts the characteristic parameters of the character pattern according to said various recognition systems.

Recognition dictionary (30) stores the standard character patterns according to said recognition system. As explained above, in the character recognition device in the application example of the present invention, the standard character patterns of a plurality of character types, such as Japanese Katakana characters, Hairagana Japanese characters, Kanji, etc.

Comparing part (33) compares the characteristic parameters of the character patterns extracted with said characteristics extracting part (32) with the standard character patterns of all of the character types stored in said recognition dictionary (30), and for each input character, a string of recognized character candidates is listed up together with the resemblance in the order of decrease in the resemblance.

Then, in post-treatment section part (34), judgment is made on whether the recognized character candidate judged as most similar with said comparing part (33) can be adopted as the final character recognition result. Depending on the judgment, if needed, the lower recognized

character candidate of said recognized character candidate string is adopted as the final character recognition result. That is, the characteristic constitution of the present invention is mainly in said post-treatment section part (34).

Display (35) displays the final character registration result output from said post-treatment section part (34).

Said recognition dictionary (30) is mainly made of a memory circuit. Input part (31), for example, has a conventional OCR or other optical scanning mechanism (such as CCD scanner, etc.), or tablet or other coordinate input mechanism. Display (35) has CRT or other display mechanism. In addition, said parts may be realized by means of a microcomputer composed of CPU, RAM, ROM, etc.

In the constitution shown in Figure 3, the constitution of post-treatment section part (34) of the present invention is schematically shown in Figure 6. That is, the post-treatment section part is composed of control part (40), character type judging part (41), candidate retrieval part (42), resemblance difference computing part (43), substitutable value storage part (44), and substitution treatment part (45).

When said recognized character candidate string is generated for the various input character images in comparing part (33) shown in Figure 3, control part (40) controls character type judging part (41), and sends an instruction that perform judgment of the character type of the first candidate in the recognized character candidate string. When character type judging part (41) judges that the character type of the first candidate of the recognized character candidate string is of the same type as that of the preceding and following characters, and only the central character located between the preceding and following characters is of a type different from that of the preceding and following characters, it determines that the central character is a character subject to possibility of substitution. For the character judged as a character subject to possibility of substitution with said character type judging part (41), candidate retrieval part (42) retrieves the recognized character candidate with the greatest resemblance and of the same character type as that of the first candidate of the recognized character candidate string for the characters preceding and following the character judged as said character subject to the possibility of substitution, and for the preceding and following characters, the recognized character candidate with the greatest resemblance and of the same character type as that of the first candidate of the recognized character candidate string for the character judged as said character subject to possibility of substitution is retrieved. Here, as the recognized character candidates for the characters before the input head character, the character type of the recognized character candidates for the second character is used. As the recognized character candidates for the characters after the final character, the character type of the recognized character candidates for the second character counted from the final character is used.

For resemblance difference computing part (43), based on the resemblance of the first candidate of the recognized character candidate string for the character subject to possibility of substitution and the characters preceding and following the character subject to possibility of substitution detected in said candidate retrieval part (42), the resemblance of the recognized character candidate with the greatest resemblance to the character judged as the character subject to possibility of substitution and of the character type equal to the first candidate of the recognized character candidate string for the characters preceding and following the character subject to possibility of substitution among the recognized character candidates for the character judged as said character subject to possibility of substitution, and the resemblance of the recognized character candidate with the greatest resemblance to the preceding and following characters and of the character type equal to the first candidate of the recognized character candidate string for the character judged as the character subject to possibility of substitution among the recognized character candidates for the characters preceding and following the character judges as said character subject to possibility of substitution, the following parameters are computed:

(Substitution possibility of character subject to possibility of substitution) = | (resemblance of the first candidate of the recognized character candidate string for the character judged as the character subject to possibility of substitution) – (resemblance of the recognized character candidate with the greatest resemblance to the character judged as the character subject to possibility of substitution and of the character type equal to the first candidate of the recognized character candidate string for the characters preceding and following the character judged as the character subject to possibility of substitution among the recognized character candidates of the character judged as the character subject to possibility of substitution) |

(Substitution possibility of the preceding and following characters) = | (resemblance of the first candidate of the recognized character candidate string for the characters preceding and following the character judged as the character subject to possibility of substitution) – (resemblance of the recognized character candidate with the greatest resemblance to the preceding and following characters and of first candidate of the recognized character candidate string for the character judged as the character subject to possibility of substitution) – (resemblance of the recognized character candidate with the greatest resemblance to the preceding and following characters and of the same character type as that of the first candidate of the recognized character candidate string for the character judged as the character subject to possibility of substitution among the recognized character candidate string for the characters preceding and following the character judged as the character subject to possibility of substitution)

For example, when the character type of the first candidate of the recognized character candidate string for said character subject to possibility of substitution and the characters preceding and following it is "O Δ O", the (absolute value) of the difference between the resemblance of the first candidate of the recognized character candidate string to the character preceding said character subject to possibility of substitution and the resemblance of the candidate with the greatest resemblance to said preceding character and of character type of Δ within the recognized character candidate string with respect to said preceding character is determined, and it is taken as d_1.

Similarly, the (absolute value) of the difference between the resemblance of the first candidate of the recognized character candidate string to said character subject to possibility of substitution and the resemblance of the candidate with the greatest resemblance to said character subject to possibility of substitution and of character type O in the recognized character candidate string for the character subject to possibility of substitution is determined, and it is taken as d_2.

In addition, the (absolute value) of the difference between the resemblance of the first candidate of the recognized character candidate string for the character following said character subject to possibility of substitution and the resemblance of the candidate with the greatest resemblance to said following character and of character type Δ within the recognized character candidate string for said following character is determined, and it is taken as d_3.

Also, for any of said characters subject to possibility of substitution and its preceding and following characters, when there exists no recognized character candidate of a different character type and on the lower level in the recognized character candidate string as explained above, instead of the (absolute value) of the corresponding resemblance, a prescribed value over the corresponding threshold to be explained later is set. /7

As shown in Figure 4, the computation results are kept in data holding part (44) of the character subject to possibility of substitution.

Based on the data kept in said holding part (44) of the character subject to possibility of substitution, substitution treatment part (45) shown in Figure 4 performs the following treatment.

First of all, said substitution possibility is compared with the preset thresholds corresponding to the character subject to possibility of substitution and the characters preceding and following said character subject to possibility of substitution, respectively, and judgment is made on whether the substitution possibility condition of the present invention is met.

In the aforementioned example, when the preset thresholds for said preceding character, the character subject to possibility of substitution, and the following character are TH1, TH2, and TH3, respectively, judgment is made on whether the substitution possibility conditions of $d_1 > TH1$, $d_2 < TH2$, and $d_3 > TH3$ are met at the same time.

If said substitution possibility conditions are all met, it is recognized that said character subject to possibility of substitution is equal to the candidate with the greatest resemblance to the character subject to possibility of substitution and of character type O within the recognized character candidate string for said character subject to possibility of substitution, that is, it is taken as equal to the candidate with the greatest resemblance to the character subject to possibility of substitution and of the same character type as the first candidate of the recognized character candidate string for the characters preceding and following the character subject to possibility of substitution among the recognized character candidates of the character subject to possibility of substitution.

When said substitution possibility conditions are not met, it is recognized that said character subject to possibility of substitution is equal to the first candidate in the original recognized character candidate string for the character subject to possibility of substitution. That is, substitution is not performed.

For example, when the character types of a continuous string of "O Δ O Δ" as explained in the above, suppose said substitution possibility is lower than said thresholds for the second and third characters. In this case, because there are two or more continuous characters subject to possibility of substitution for which the substitution possibility is lower than said thresholds, the function corresponding to recognition correcting means (5) (Figure 2) set according to said Embodiment 2 of the present invention operates.

That is, when there exist two or more continuous characters subject to possibility of substitution without performing substitution in three continuous characters, it is recognized that the character with the minimum substitution possibility among said continuous character subject to possibility of substitution is equal to the candidate with the greatest resemblance to the character with the smallest [substitution possibility] among those of the same character type as that of the first candidate in the recognized character candidate string for the characters preceding and following the character with the smallest substitution possibility. That is, among said continuous characters subject to possibility of substitution, substitution is performed for the character with the smallest substitution possibility.

In the following, specific example will be made on an example of the case when the treatment performed with said substitution treatment part (45) obtains the recognition result shown in Figure 6 in comparing part (33) shown in Figure 3.

Figure 6 shows the substitution possibilities computed from the recognition results of Figure 6 for the character corresponding to input of "HA", the character corresponding to input of "A", and the character corresponding to input of "MO", respectively.

As explained above, the first character type of the recognition result (recognized character candidate string) shown in Figure 6 becomes "O Δ O Δ Δ". For example, all of the

first - third are said characters subject to possibility of substitution. Here, suppose said thresholds TH1, TH2, TH3 are all 50, as shown in Figure 6, the substitution possibilities for all of the characters are smaller than the threshold of 50. Consequently, in any case, the substitution possibility condition based on Embodiment 1 of the present invention is not met, and substitution with said substitution possibility condition is not performed.

Then, the function of the recognition correcting means according to Embodiment 2 of the present invention works.

Substitution possibilities are compared for "HA", "A", "MO" [「 ― 」 、 「 モ 」] extracted as characters subject to possibility of substitution and judged to meet the substituting condition, and it is found that the substitution possibility of 3 for "A" [「 ― 」] is the smallest. Consequently, for "A" [「 ― 」], substitution is performed according to the function of the recognition correcting means in Embodiment 2 of the present invention.

As far as substitution of said input "A" [「 ― 」] to the corresponding character is concerned, the recognition of Kanji "ONE" [「 ― 」] at the first place of the recognized character candidate string for the characters corresponding to said input of "A" [「 ― 」] is that in the recognized character candidate string for the characters corresponding to said input of "A" [「 ― 」], it should   /8 be replaced with the third Katakana Japanese character "A" [「 ― 」] with the greatest resemblance to the character corresponding to said input "A" [「 ― 」] of the same character type as the first character type of the recognized character candidate string for the characters preceding and following the character corresponding to said input "A" [「 ― 」]. In this way, the portion of the original Japanese Katakana character "HA A MO" [「 ハ ― モ 」] has been recognized correctly.

In this way, according to the constitution of the application example of the present invention shown in Figures 3 and 4, for the input of Japanese Katakana character "HA A MO NI KA" [「 ハ ― モ ニ カ 」], the recognition result of "HA A MO TWO FORCE" [「 ハ ― モ 二 力 」] (where "TWO" (「二」) and "FORCE" [「力」] are Kanji) is displayed.

Figure 5 is a flow chart illustrating the sequence of the treatment of the application example in the present invention as explained above.

As shown in Figure 5, after START (step 500), in step 501, first of all, the head character is taken as the central character. In step 502, the first candidate character type is detected for said central character and the characters preceding and following said central character (for, example, see Figure 6). In step 503, if the first candidate character types of the recognized character candidate string for the preceding and following characters are of the same character type, and it is different from the first candidate character type of the recognized character candidate string for said central character (that is, the central character is a character subject to possibility of substitution), it goes to step 504. On the other hand, if it is otherwise in step 503, it goes to step

508, and the next character of the input character string is taken as the central character. It then goes to step 502.

In said step 504, in the recognized character candidate string for said central character, the candidate with the greatest resemblance to the central character among the candidates equal to the first candidate of the recognized character candidate string for the characters preceding and following the central character is detected, and, in the recognized character candidate string for the characters preceding and following the central character, the candidate with the greatest resemblance to said preceding and following characters among the candidates of the character type equal to that of the first candidate of the recognized character candidate string for the central character is detected.

In step 505, for said central character, the substitution possibility is determined as the difference between the resemblance of the first candidate of the recognized character candidate string to said central character and the resemblance of the candidate with the greatest resemblance to the central character and of the candidate of the character type equal to that of the first candidate of the recognized character candidate string for the characters preceding and following the central character. Also, for said characters preceding and following said central character, the substitution possibility is determined as the difference between the resemblance of the first candidate of the recognized character candidate string to the characters preceding and following said central character and the resemblance of the candidate with the greatest resemblance to the characters preceding and following said central character and of the candidate having the character type equal to that of the first candidate of the recognized character candidate string for said central character in said recognized character candidate string.

In step 506, the data of said substitution possibility is stored (in data holding part (44) of character subject to possibility of substitution shown in Figure 4).

In step 507, judgment is made on whether said treatment has been carried out for all of the characters in the input character string as the central character. If treatment for all of the characters has not been finished, it goes to said step 508 again. If it has been finished, it goes to step 509.

In steps 509~514, when all of the characters in said input character string have been taken as the central character, for each of them, judgment is made on whether said substitution possibility conditions $d_1 > TH1$, $d_2 < TH2$, and $d_3 > TH3$ are met as the same time. If these substitution possibility conditions are met, in step 512, it is recognized that instead of the first candidate of the recognized character candidate string for the central character, the central character is equal to the candidate with the greatest resemblance to the central character and of the candidate having the same character type as that of the first candidate of the recognized character candidate string for the characters preceding and following the central character.

In step 513, judgment is made on whether the aforementioned treatment has been performed for all of the characters in the input character string as the central character, and if the treatment has been finished for all of the characters, it goes to step 515.

In steps 515-525, judgment is made for all of the characters in said input character string on whether there are two or more continuous characters subject to possibility of substitution with substitution possibility below the threshold. Also, it shows a sequence of recognition that said central character is not the first candidate of the recognized character candidate string for the character with the smallest substitution possibility (said difference between similarities) among the two or more continuous characters subject to possibility of substitution with a substitution possibility lower than the threshold, instead it is equal to the candidate with the highest resemblance to the character and of the candidate having the same character type as that of the first candidate of the recognized character candidate string for the characters preceding and following the character in the recognized character candidate string for the character.

/9

That is, in steps 515-517, characters subject to possibility of substitution with substitution possibility smaller than the threshold are searched for sequentially from the head character. If there exists a character subject to possibility of substitution with substitution possibility smaller than the threshold, in steps 518-519, judgment is made on whether the next character is also a character subject to possibility of substitution having a substitution possibility smaller than the threshold. When in step 519 it is judged that there are two continuous characters subject to possibility of substitution with a substitution possibility smaller than the threshold, it goes to steps 520 and 521, and it is detected where the characters subject to possibility of substitution with a substitution possibility smaller than the threshold are present continuously. In step 522, the character with the smallest substitution possibility (the difference in similarities) among the continuous characters subject to possibility of substitution with a substitution possibility smaller than the threshold is determined. Then, in step 523, it is recognized that the character with the smallest substitution possibility is not the first candidate of the recognized character candidate string for the character. Instead, it is equal to the candidate with the greatest resemblance to the character and of the candidate having the same character type as that of the first candidate of the recognized character candidate string for the characters preceding and following the character in the recognized character candidate string for the character. That is, substitution is carried out.

Then, in step 524, judgment is made on whether the aforementioned treatment has been performed for all of the characters of the input character string. If the treatment has been finished for all of the characters, it goes to step 521, and the treatment comes to an end.

Effect of the invention

According to the present invention, when there exists a character of a type different from that of characters of a certain type sandwiching said character, it is possible to judge whether the character of the different character type should be substituted to a character of a character pattern with the greatest resemblance among the character candidates of the same character type as that of the characters preceding and following the character of the different character type. As a result, the performance in the correcting treatment in the character recognition device can be improved.

Brief description of the figures

Figure 1 is a diagram illustrating the basic constitution of Embodiment 1 of the present invention.

Figure 2 is a diagram illustrating the basic constitution of Embodiment 2 of the present invention.

Figure 3 is a diagram schematically illustrating the hardware constitution of the character recognition device.

Figure 4 is a diagram schematically illustrating the constitution of the post-treatment section part in the constitution of Figure 3.

Figure 5 is a diagram illustrating the sequence of treatment in an application example of the present invention.

Figure 6 is a diagram illustrating an example of the recognition result using the comparing part of the character recognition device shown in Figure 3.

Brief description of part numbers

1   Dictionary

2   Recognized character candidate selecting means

3   Substitution possibility computing means

4   Recognized character treatment means

5   Recognition correcting means

30   Recognition dictionary

31   Input part

32   Characteristics extracting part

33   Comparing part

34   Post-treatment section part

35   Display

40   Control part

41   Character type judging part

42   Candidate retrieval part

43   Resemblance difference computing part

44   Substitution possibility value storage part

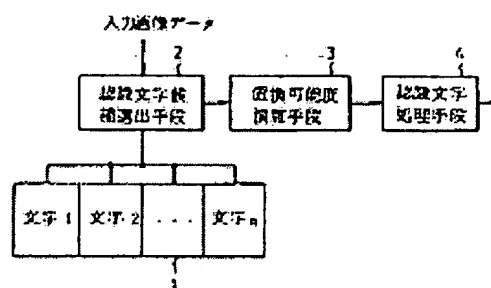45   Substitution treatment part

Figure 1. Diagram illustrating the basic constitution of Embodiment 1 of the present invention.

Key: a   Input image data
       b   Character
       2   Recognized character candidate selecting means
       3   Substitution possibility computing means
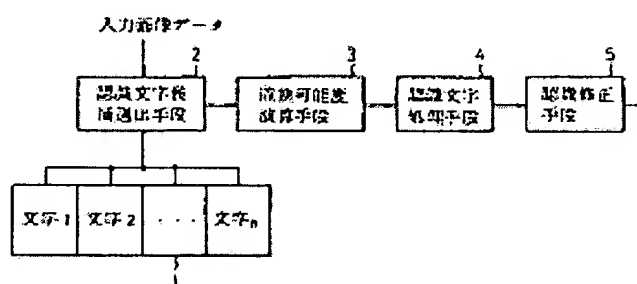   4   Recognized character treatment means

Figure 2. Diagram illustrating the basic constitution of Embodiment 2 of the present invention.

Key: a   Input image data
       b   Character
       2   Recognized character candidate selecting means
       3   Substitution possibility computing means
       4   Recognized character treatment means
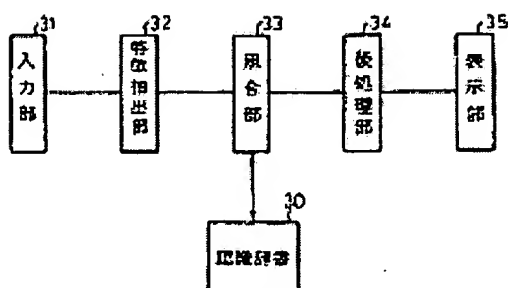   5   Recognition correcting means

Figure 3. Diagram schematically illustrating the hardware constitution of the character recognition device.

Key: 30   Recognition dictionary
      31   Input part
      32   Characteristics extracting part
      33   Comparing part
      34   Post-treatment section part
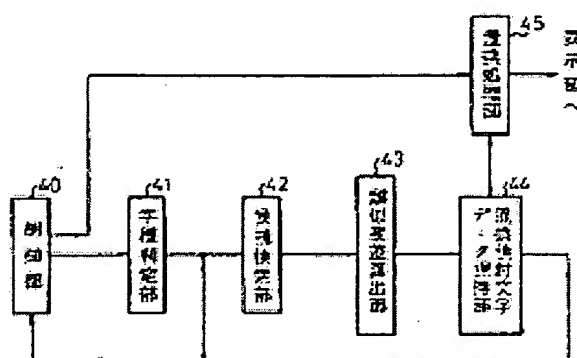   35   Display

Figure 4. Diagram schematically illustrating the constitution of the post-treatment section part in the character recognition device in the application example of the present invention.

Key: a   To the display
      40   Control part
      41   Character type judging part
      42   Candidate retrieval part
      43   Resemblance difference computing part
      44   Substitution possibility value storage part
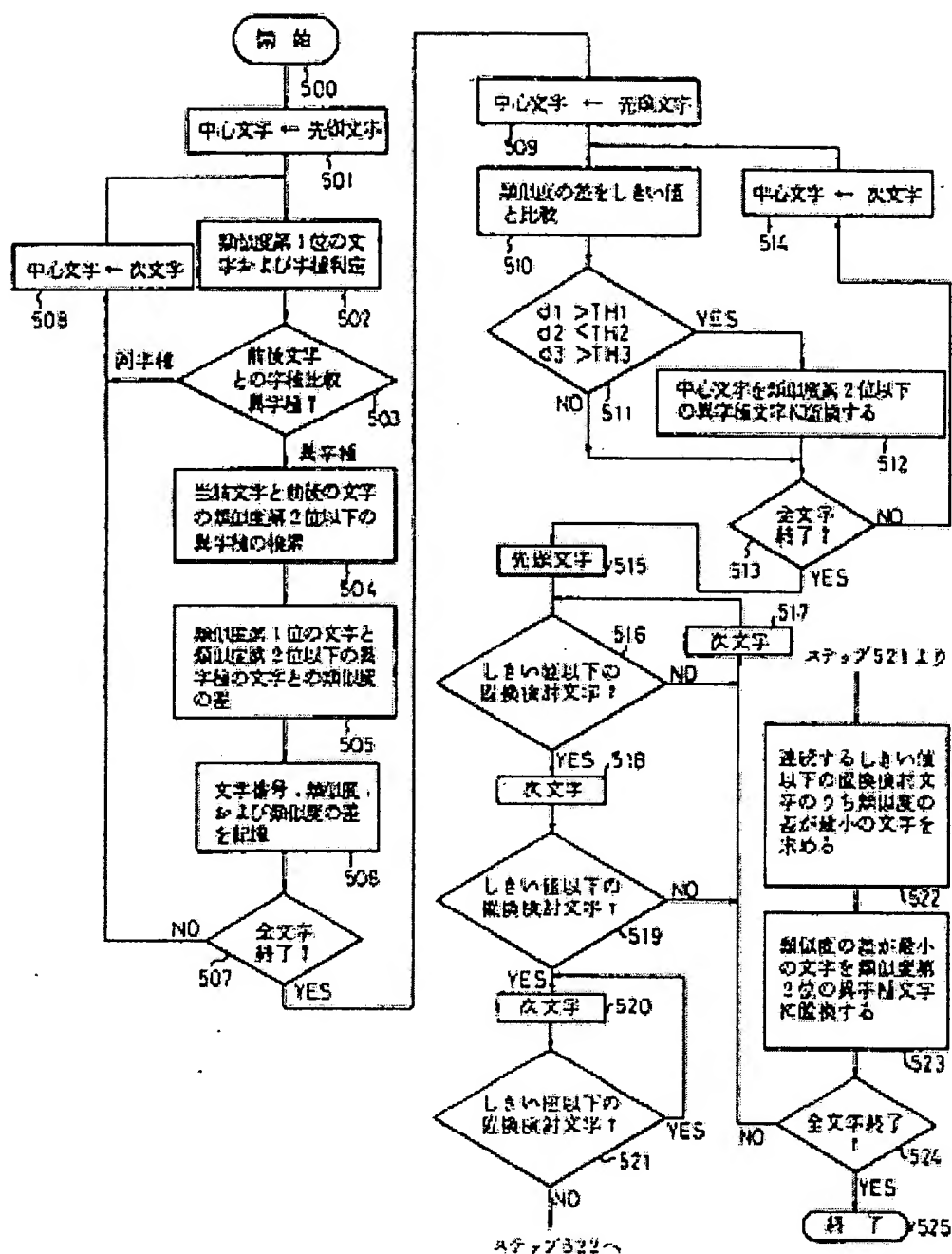   45   Substitution treatment part

Figure 5. Diagram illustrating the sequence of treatment in an application example of the present invention.

Key: a   Same character type
          b   Different character type
          c   From step 521

d   To step 522
500   START
501   Central character ← head character
502   Judgment of character with the first resemblance and the character type
503   Is the character type different from that of the preceding and following
        characters?
504   Retrieval of the different character type with resemblance of the second and later
        place between the specific character and the preceding and following characters
505   Difference in resemblance between the character with the first resemblance and
        the character of the different character type and having resemblance of the second
        and later place
506   Storage of character number, resemblance, and difference in resemblance
507   End for all of the characters?
508   Central character ← next character
509   Central character ← head character
510   Comparison of the difference in resemblance with threaded
512   Substitution of the central character with the character of different character type
        having second or lower resemblance
513   End for all of the characters?
514   Central character ← next character
515   Head character
516   Character subject to possibility of substitution lower than threshold?
517   Next character
518   Next character
519   Character subject to possibility of substitution lower than threshold?
520   Next character
521   Character subject to possibility of substitution lower than threshold?
522   Character with the smallest difference in resemblance among the continuous
        characters subject to possibility of substitution smaller than the threshold
523   Character with the smallest difference in resemblance is replaced with the
        character of the different character type having the second resemblance
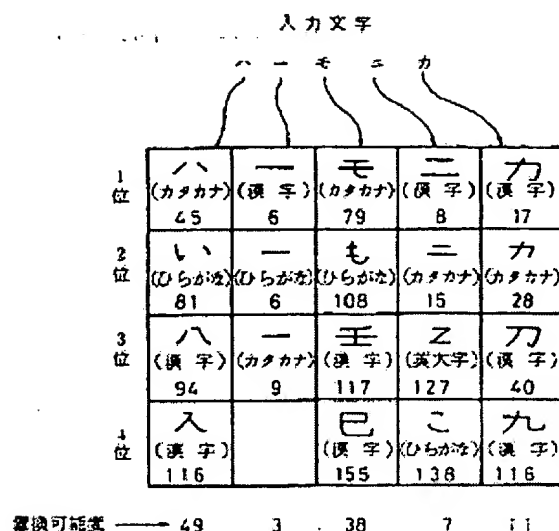524   End of all of the characters
525   End

入力文字

ハ 一 モ 二 カ

	ハ (カタカナ) 45	一 (漢字) 6	モ (カタカナ) 79	二 (漢字) 8	カ (漢字) 17
1 位					
2 位	い (ひらがな) 81	一 (ひらがな) 6	も (ひらがな) 108	二 (カタカナ) 15	カ (カタカナ) 28
3 位	ハ (漢字) 94	一 (カタカナ) 9	壬 (漢字) 117	Z (英大字) 127	刀 (漢字) 40
4 位	入 (漢字) 116		巳 (漢字) 155	こ (ひらがな) 138	九 (漢字) 116

置換可能度 —— 49 3 38 7 i i

Figure 6. Diagram illustrating an example of the recognition result using the comparing part.

Key:
1	First place
2	Second place
3	Third place
4	Fourth place
5	Substitution possibility
6	Input character
7	HA
8	A
9	MO
10	NI
11	KA
12	HA (Japanese Katakana character) 45
13	ONE (Kanji) 6
14	MO (Japanese Katakana character) 79
15	TWO (Kanji) 8
16	FORCE (Kanji) 17
17	I (Hairagana Japanese character) 81
18	I (Hairagana Japanese character) 6
19	MO (Hairagana Japanese character) 108
20	NI (Japanese Katakana character) 15
21	KA (Japanese Katakana character)
22	HA (Kanji) 94
23	A (Japanese Katakana character) 9
24	NINTH (Kanji) 117
25	Z (upper-case English character)
26	KNIFE (Kanji) 40
27	ENTER (Kanji) 116
28	SIXTH (Kanji) 155